PATENT SPECIFICATION

DRAWINGS ATTACHED

955,013

955,013

Date of Application and filing Complete Specification Nov. 17, 1961.

No. 41285/61.

Application made in France (No. 844347) on Nov. 18, 1960.

Complete Specification Published April 8, 1964.

The inventor of this invention in the sense of being the actual deviser thereof within the meaning of Section 16 of the Patents Act 1949, is Korad August Werner Eichholtz, a German citizen of Ilbis Avenue Marechal Foch, Dammarie-les-Lys Seine et Marne, France.

Index at acceptance: —F1 J(2A1A, 2A1C, 2A1D, 2A1E, 2B4, 3)

International Classification: —F 02 k

COMPLETE SPECIFICATION

Improvements in or relating to Composite Jet Engines

We, SOCIETE NATIONALE D'ETUDE ET DE CONSTRUCTION DE MOTEURS D'AVIATION, a French Body Corporate of 150 Boulevard Haussmann, Paris, Seine, France, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement: —

The present invention relates to composite jet engines, i.e. engines which have at least two co-operating thermodynamic channels operable along different thermodynamic cycles; an example of such an engine is the combined "turbo-ram" which has a turbojet housed coaxially within a ramjet, the two units being operable alternatively or simultaneously as the case may be.

The object of this invention is to provide a composite jet engine which supplies a large thrust, especially when stationary and at supersonic speeds, and which can operate over the whole range of speeds with small specific consumption, even at small partial loads.

Reverting to the above-mentioned turbo-ram engines, it is well known that at high supersonic speeds, the power of these engines is very great, especially by reason of the large flow-rates of air in the ram-jet, and their specific consumption can be low in consequence of the high compression in the intake stream of each channel of the engine. However, when the speed of flight decreases, the contribution of the ram-jet to the thrust of the engine diminishes, and when taking-off, the thrust, supplied solely by the turbo-jet, is small.

The so-called turbofan or by-pass turbo-jet engines are also known, in which it is possible to obtain very favourable specific consumptions at subsonic and moderate supersonic speeds, the division of the stream of air passing through the engine into a main flow and a by-pass flow enabling the appropriate pressure ratio to be chosen for each. However, the great difference in the pressures which are created at high speeds of flight in the two flows gives rise to pressure losses in the case where the two flows are mixed before they are ejected from a single discharge-nozzle. Furthermore, a convergent-divergent discharge-nozzle with two coaxial outlets adjustable in flight is complicated and bulky, especially when after-burning devices are employed.

The compound jet engine forming the subject of the present invention is designed to combine the favourable characteristics of the turbofan or by-pass turbojet engine at the lower speeds with those of the combined turbo-jet and ram-jet at the higher speeds, this engine being operable along one or more of the respective thermodynamic cycles according to need.

According to the invention there is provided a composite jet engine designed for efficient operation in the subsonic as well as high supersonic range of aircraft speed, comprising a first jet propulsion channel ending rearwardly with an adjustable convergent-divergent nozzle, a second jet propulsion channel ending rearwardly with a further and distinct adjustable convergent-divergent nozzle, at least one adjustable convergent-divergent ramming intake at the front end of said channels, a gas generator within said first channel designed to supply the nozzle thereof with motive gas and also to supply power for driving an air compressing means,

a combustion chamber within said second channel intermediate the ramming intake and nozzle thereof whereby said second channel is operable substantially in accordance with a ram-jet cycle, a low-pressure compressor in said second channel positioned upstream of said combustion chamber, a turbine drivingly connected to said compressor, a further and separate combustion chamber connected with the inlet of said turbine, and an interconnecting conduit extending between said channels for supplying said further combustion chamber with compressed air delivered by said compressing means whereby said second channel is operable substantially in accordance with a turbofan cycle.

The second channel may comprise, upstream of the nozzle thereof, a mixture chamber into which the low-pressure compressor discharges and the turbine exhausts. After-burning means may be positioned downstream of the turbine.

The low-pressure compressor may comprise orientatable stator blades pivotable about radial axes, and means for adjusting the angular setting of said blades, whereby the output and pressure ratio of said low-pressure compressor is accordingly varied.

The two channels may merge with one another at the front end thereof and have a common adjustable convergent-divergent ramming intake, and distributing means may be provided for variably proportioning the air flow from said common ramming intake, between the two channels. The distributing means may comprise a pivotal flap positioned in the merging zone of said channels.

Controllable means may be provided for tapping compressed air from the interconnecting conduit.

The air compressing means may comprise an air compressor sucking downstream of the ramming intake, a turbine drivingly connected with said air compressor and having its exhaust connected to the nozzle of the first channel, the gas generator supplying motive gas to said turbine and nozzle, said generator comprising a gas-turbine unit mechanically independent from said compressor and turbine.

When comparing under similar conditions the two channels of the engine according to the invention with the two independent channels in simultaneous operation of a combined turbo-ram, it is found that over large range of temperatures of heating and reheating, the additional compression due to the low-pressure compressor results in a smaller increase of entropy in the flow discharged from the second channel than in that of the ram-jet.

Furthermore, the losses in the turbine serving to absorb the useful power of motive-gas generator, cause a supplementary increase of entropy in the flow discharged from the first channel which does not exist in that of the turbo-jet. For the whole range of speeds up to beyond the point of operation at which the admission pressure at the compressor of the gas generator is equal to the pressure downstream of its turbine, it is found that the sum of the increases of entropy in the two channels is less for the engine according to the invention than for the combined turbo and ram-jet used for comparison, which means that the engine of the present invention has a higher thermodynamic efficiency.

At high supersonic speeds, the pressure in the two channels is very different, but the two discharge-nozzles can be adjusted in consequence and can operate with the minimum loss. The operative cycle of the second channel is very close to that of a ram-jet. In order to operate the engine at maximum power at these speeds of flight, with heating and after-burning, the flow-rate of the second channel can be substantially increased by increasing the setting angle of the blades of the stationary rows of the low-pressure compressor, in which the compression ratio decreases in this case to the vicinity of 1, the speed remaining appropriate.

This arrangement may offer certain advantages in the case of installation of the engine on aircraft, and results in a very great flexibility of the engine.

Thus, when operating at maximum flow-rate with heat and re-heat, the increase in power is very substantial as compared with normal operation.

At low partial loads, without heat or re-heat, with reduced flow-rate and increased pressure ratio, as the turbine can operate at reduced temperature, the heating of the cold flow of the second channel is effected solely by mixture with the exhaust gases of the turbine. The engine can operate with good efficiency without change in the speed of the gas generator. The working of the gas generator at constant speed under different conditions of flight is advantageous, especially for driving the auxiliary apparatus on board.

For the same reason, this engine is well suited to rapid changes of power.

The invention is illustrated by way of example in the accompanying drawing in which the single figure is a diagrammatic longitudinal section of a composite jet engine constructed in accordance with the present invention.

The jet engine shown in the drawing comprises two separate channels 1 and 2, terminating in separate convergent-divergent discharge-nozzles 3 and 4 which are adjustable when stationary and in flight by means not shown. In the example of the drawing, these channels have a common ramming intake 5 which is also convergent-divergent and adjustable when stationary and in flight.

The line of separation of the two flows comprises, when so required, a movable flap 6 which facilitates the adaption of the channels to the required distribution of the flow-rates. It is however quite obvious that it is possible to replace the common intake 5 by separate adjustable supersonic intakes for the two channels.

In the channel 1 is housed a compressor 7, the rotor of which is coupled by a shaft 8 to a separate turbine 9 working on the downstream side of a gas generator consisting of a compressor 11, a combustion chamber 13 and a turbine 10, the gases being discharged from the adjustable convergent-divergent nozzle 3.

The compressor 7 delivers into a conduit 14 equipped when so required with a valve 15 and a tapping 23. This conduit delivers into a combustion chamber 16 which supplies a turbine 17 coupled by a shaft 18 to a low-pressure compressor 19 which is provided with a device shown diagrammatically at 24 and which permits the changing of the setting of the blades of all or part of the stationary rows such as 25 and 26. The turbo-compressor group 17—19 with the combustion chamber 16 is arranged in the passage 2. An annular channel 20, formed between the casing of this group and the wall of the channel 2 is provided with burners 27 whereby the passage 20 constitutes a combustion chamber fed with air pressurised by said ramming intake 5 and/or said low-pressure compressor 19. This air is then mixed with the exhaust gases of the turbine 17 in a chamber 21 equipped with after-burners 22 and is finally ejected from the adjustable convergent-divergent discharge nozzle 4.

The invention is not limited to a composite engine having only two channels such as 1 and 2, but includes for example arrangements in which a channel 1 supplies compressed air to several channels such as 2.

WHAT WE CLAIM IS:—

1. A composite jet engine designed for efficient operation in the subsonic as well as high supersonic range of aircraft speed, comprising a first jet propulsion channel ending rearwardly with an adjustable convergent-divergent nozzle, a second jet propulsion channel ending rearwardly with a further and distinct adjustable convergent-divergent nozzle, at least one adjustable convergent-divergent ramming intake at the front end of said channels, a gas generator within said first channel designed to supply the nozzle thereof with motive gas and also to supply power for driving an air compressing means, a combustion chamber within said second channel intermediate the ramming intake and nozzle thereof whereby said second channel is operable substantially along a ramjet cycle, a low-pressure compressor in said second channel positioned upstream of said combustion chamber, a turbine drivingly connected to said compressor, a further and separate combustion chamber connected with the inlet of said turbine, and an interconnecting conduit extending between said channels for supplying said further combustion chamber with compressed air delivered by said compressing means whereby said second channel is operable substantially along a turbofan cycle.

2. An engine as claimed in claim 1, wherein the second channel comprises, upstream of the nozzle thereof, a mixture chamber into which the low-pressure compressor discharges and the turbine exhausts.

3. An engine as claimed in claim 1 or 2, further comprising after-burning means positioned downstream of the turbine.

4. An engine as claimed in any preceding claim, wherein the low-pressure compressor comprises orientatable stator blades pivotable about radial axes, and means for adjusting the angular setting of said blades, whereby the output and pressure ratio of said low-pressure compressor is accordingly varied.

5. An engine as claimed in any preceding claim, wherein the two channels merge with one another at the front end thereof and have a common adjustable convergent-divergent ramming intake, said engine further comprising distributing means for variably proportioning the air flow from said common ramming intake, between the two channels.

6. An engine as claimed in claim 5, wherein the distributing means comprises a pivotal flap positioned in the merging zone of said channels.

7. An engine as claimed in any preceding claim, further comprising controllable means for tapping compressed air from the interconnecting conduit.

8. An engine as claimed in any preceding claim, wherein the air compressing means comprises an air compressor sucking downstream of the ramming intake, a turbine drivingly connected with said air compressor and having its exhaust connected to the nozzle of the first channel, the gas generator supplying motive gas to said turbine and nozzle, said generator comprising a gas-turbine unit mechanically independent from said compressor and turbine.

9. A composite jet engine constructed and arranged as herein described with reference to the accompanying drawings.

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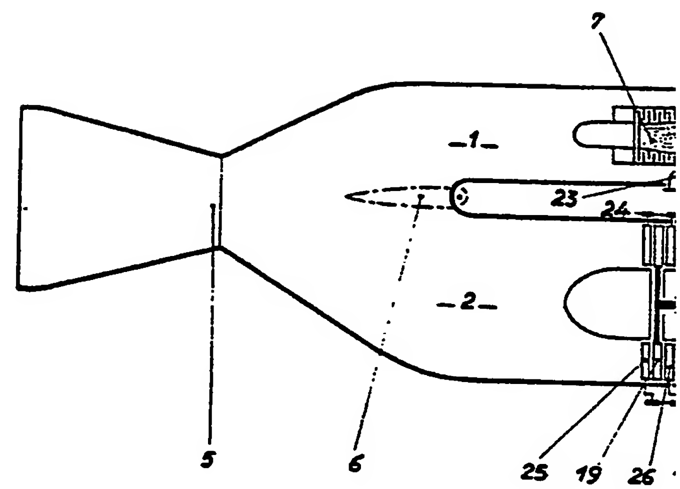
Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1964.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.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955013 COMPLETE SPECIFICATION

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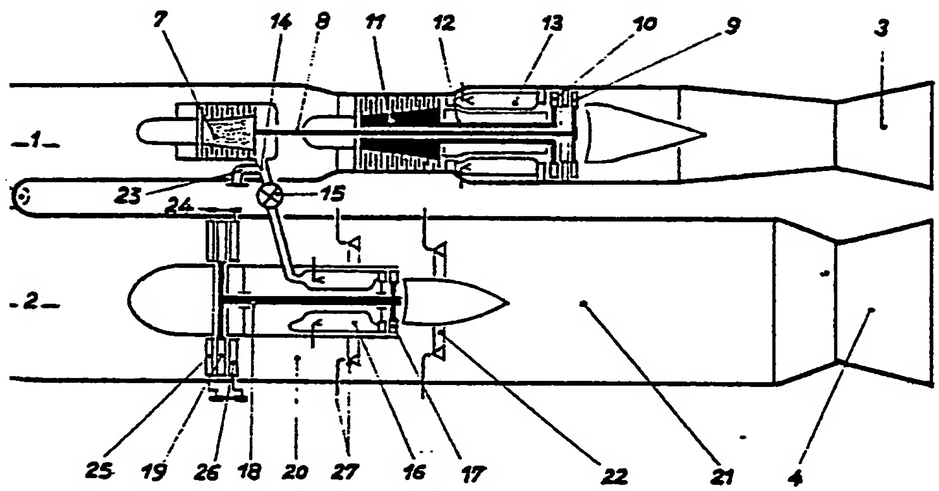

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